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(71) Applicant: KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors: WOLTERS, Hans, H.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). BENEDICTUS, Jan, H.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(74) Agent: CUPPENS, Hubertus, M., M.; Internationaal Octrooibureau B.V., Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

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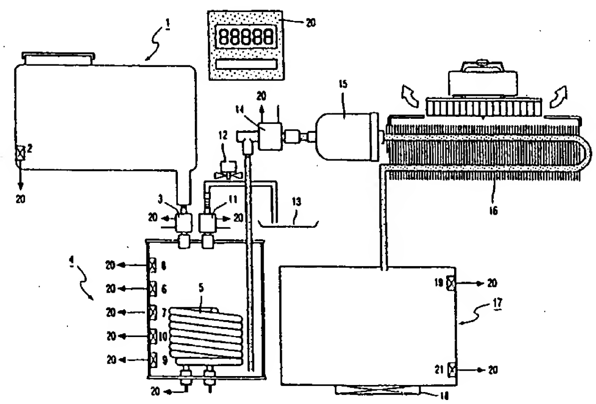

(57) Abstract

A water treatment apparatus which comprises an inlet for unpurified water, a boiler (4) for purifying water by heating, a heating means (5) for heating the water in the boiler (4), and an outlet for purified water. The transport of water through the apparatus takes place by means of, respectively, an overpressure and an underpressure, which originate in the boiler (4) during, respectively, a first and a second phase of a heat-exchanging process. The first phase of the heat-exchanging process comprises heating of the water in the boiler (4) until a predetermined temperature is reached, and maintaining this temperature during a predetermined period of time. The second phase of the heat-exchanging process comprises condensation through cooling of vapor, until a predetermined temperature is reached, said vapor being generated by heating the water during the first phase. By virtue of the above-mentioned way of transporting water through the apparatus, the water treatment apparatus does not need a pump or a continuous connection to the water main for transporting water.

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Water treatment apparatus.

The invention relates to a water treatment apparatus comprising an inlet for unpurified water, a heating chamber for purifying water by heating, a heating source for heating water in the heating chamber, an outlet for purified water.

A water treatment apparatus of the type mentioned in the opening paragraph is known from US 4,844, 796.

The known apparatus is used in a beverage dispenser system, wherein water is mixed with a syrup, to sterilize water in advance and remove hardness and impurities from the water. The known apparatus comprises a removable, disposable purification cartridge comprising two sections. The first section includes a reactor filled with sand, carbon granules or other heat-conducting material to remove bicarbonates and other impurities. The second section includes a filter with a carbon screen for removing solids, chlorine and dissolved organic material from the water.

In this apparatus, water purification takes place in the following manner. Unpurified tap water flows from a first storage tank or from a water main by means of a pump or by pressure in the water main, via the inlet, to the first section of the purification cartridge, i.e. the reactor. This section comprises the heating chamber wherein heating of the water takes place by successive heating sources, namely, respectively, a heat exchanger and an electrical heating element. As a result, bicarbonates and other impurities precipitate on a heat-conducting material in the reactor. The heated water subsequently travels from the first section of the purification cartridge to a second storage tank having a water vapor outlet. In a head space of the second storage tank, gases, such as carbon dioxide and chlorine, collect which are released through the water vapor outlet.

Subsequently, the water travels from the second storage tank to the second section of the purification cartridge, i.e. the filter. This filter removes solids and other residual impurities from the water. From the second section of the purification cartridge, the water again travels past the heat exchanger in the first section of the purification cartridge, so that the purified water is cooled by the incoming cold unpurified water in the heat exchanger. The cooled purified water then travels, via the outlet of the water treatment apparatus, to a mixing

device of the beverage dispenser system. This water treatment apparatus generates a continuous flow of purified, cool water at the outlet.

A drawback of the known apparatus resides in that the transport of water through the water purification apparatus takes place by means of the above-mentioned pump or by means of the pressure in the water main. The apparatus must therefore be provided with a pump, which means that an additional component must be incorporated in the apparatus or, during operation, the apparatus must be continuously in communication with the water main.

It is an object of the invention to provide a water treatment apparatus of the type mentioned in the opening paragraph, wherein transport of water through the apparatus can be achieved without a pump and without continuous communication with the water main.

This object is achieved by a water treatment apparatus in accordance with the invention which is characterized in that, in operation, transport of purified water from the heating chamber to the outlet, and transport of unpurified water from the inlet to the heating chamber, take place in the apparatus by means of, respectively, an overpressure and an underpressure, which develop in the heating chamber during, respectively, a first phase and a second phase of a heat-exchange process in the heating chamber. As the transport of water through the apparatus takes place by means of the overpressure and the underpressure in the heating chamber, which develop during, respectively, the first phase and the second phase of the heat-exchange process in the heating chamber, a pump or continuous connection to the water main is not necessary. An overpressure in the heating chamber causes the water present there to flow from said heating chamber, while an underpressure in the heating chamber causes unpurified water to flow into the heating chamber. Use can be made of control means to guide the water from the heating chamber to the outlet, and from the inlet to the heating chamber.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the first phase of the heat-exchange process includes heating of the unpurified water present in the heating chamber to a predetermined temperature, and maintaining said temperature during a predetermined period of time. Heating of the unpurified water in the heating chamber during the first phase of the heat-exchange process takes place to kill bacteria in the water, thereby purifying the water. The overpressure in the heating chamber built-up during heating is subsequently used to transport the purified water to the outlet. In this manner, the first phase of the heat-exchange process is used efficiently.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the apparatus comprises a discharge valve between the

heating chamber and the outlet, which discharge valve is closed during the first and the second phase of the heat-exchange process and open during a transport phase between the first and the second phase of the heat-exchange process. As the discharge valve is closed during the first and the second phase of the heat-exchange process, the build-up of the overpressure in the first phase and the underpressure in the second phase is not disturbed by an open communication with the outlet, and purified water is prevented from flowing back into the heating chamber after the transport phase. The use of the discharge valve enables the flow of purified water traveling from the heating chamber to the outlet to be controlled in a practical manner.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the second phase of the heat-exchange process includes condensation as a result of cooling water vapor present in the heating chamber to a predetermined temperature, which water vapor is formed by heating water during the first phase of the heat-exchange process. As a result of said condensation, a relatively large underpressure develops in the heating chamber, which causes the unpurified water to flow into the heating chamber relatively rapidly.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the apparatus comprises an intake valve between the inlet and the heating chamber, which intake valve is closed during the first and the second phase of the heat-exchange process and open during a further transport phase after the second phase. As the intake valve is closed during the first and the second phase of the heat-exchange process, the build-up of the overpressure in the first phase and the underpressure in the second phase is not disturbed by an open communication with the inlet, so that the unpurified water is prevented from flowing back from the heating chamber to the inlet after the further transport phase. The use of the intake valve enables the flow of unpurified water traveling from the inlet to the heating chamber to be controlled in a practical manner.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the heat-exchange process in the apparatus is a cyclic process. In this particular embodiment, the two phases of the heat-exchange process in the apparatus are repeated as long as unpurified water is available at the inlet. The successive cycles repetitively generate a quantity of purified water at the outlet. In this manner, a continuous production of purified water can be achieved, while the dimensions of the heating chamber can be limited.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the apparatus comprises a storage tank for unpurified water

which is situated in a higher position than the heating chamber. By applying said storage tank which is situated in a higher position than the heating chamber, use is made of the force of gravity to fill the heating chamber during a start-up phase wherein there is no underpressure yet in the heating chamber. In this manner, special means for filling the heating chamber during the start-up phase can be dispensed with.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the apparatus comprises a closable water vapor outlet allowing water vapor with vaporous or gaseous impurities, which is formed during the first phase of the heat-exchange process, to be released from the heating chamber. By using said closable water vapor outlet, the impurities as well as a part of the water vapor are released from the heating chamber after the first phase as soon as the water vapor outlet is open. In this manner, the impurities are relatively rapidly discharged from the heating chamber.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the apparatus is provided with a condenser for the condensation of the water vapor with impurities, and with a drip can for receiving the condensed water vapor with impurities. By using the condenser and the drip can, it is counteracted that the impurities travel to undesirable places in the water treatment apparatus through dissemination of the discharged water vapor, or that they are disseminated into the air in the surroundings of the water treatment apparatus.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the apparatus comprises an elastic membrane in the heating chamber. By using said elastic membrane, the heating chamber can be entirely, i.e. up to the membrane, filled with water prior to the first phase. When the water is subsequently heated, the membrane takes care of the increase in volume caused by the expansion of the water and the formation of the water vapor, so that too large a pressure on the heating chamber is precluded. By using the membrane, a level regulation in the heating chamber can be dispensed with, which helps to counteract malfunction and calcification.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that the apparatus comprises, in the heating chamber near the membrane, a partition with apertures. Said partition supports the membrane during the second phase of the heat-exchange process, so that undesirable bending of the membrane under the influence of the underpressure is precluded during this phase. The application of said apertures in the partition enables the heating chamber to be filled up to the membrane.

A particular embodiment of a water treatment apparatus in accordance with the invention is characterized in that, between the inlet and the outlet, the apparatus comprises at least two parallel-arranged heating chambers wherein, in operation, the two phases of the heat-exchange process take place in phase opposition. By using said, at least two, parallel-arranged heating chambers, a large quantity of purified water is efficiently generated and a more uniform transport of water, and hence a more uniform production of purified water, is achieved.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 diagrammatically shows a first embodiment of the water treatment apparatus in accordance with the invention,

Figs. 2a, 2b and 2c diagrammatically show a heating chamber of a second embodiment of the water treatment apparatus in accordance with the invention during a number of successive phases in a water treatment process, the heating chamber comprising a membrane, and

Fig. 3 diagrammatically shows a third embodiment of the water treatment apparatus in accordance with the invention, said apparatus comprising two heating chambers.

The first embodiment of the water treatment apparatus in accordance with the invention, as shown in Fig. 1, comprises an inlet for unpurified water, a heating chamber 4 for purifying water by heating, a heating source 5 for heating water in the heating chamber 4, and an outlet for purified water. The inlet for unpurified water is formed, in this embodiment, by a storage tank 1 for unpurified water, which is connected to the heating chamber 4 via a closable intake valve 3. The storage tank 1 comprises a first level sensor 2 and is situated in a higher position than the heating chamber 4. Apart from the heating source 5, the heating chamber 4 comprises a closable water vapor outlet 11, which is connected to a drip can 13 via a condenser 12. In this embodiment, the heating chamber 4 further includes a temperature sensor 6, a timer 7, a second level sensor 8, a third level sensor 9 and a pressure sensor 10, and, in this embodiment, the heating chamber 4 is connected to a closable discharge valve 14. The timer 7 may alternatively be embodied so as to be a time function in the processor 20, and the

pressure sensor 10 may be replaced by a temperature sensor. The water treatment apparatus comprises, after the closable discharge valve 14, respectively, a filter 15 and a heat exchanger 16. The heat exchanger 16 is in communication with the outlet, which in this embodiment is formed by a further storage tank 17 for purified water. Said further storage tank 17 comprises a cooling element 18, a fourth level sensor 19 and a fifth level sensor 21. In this embodiment, the intake valve 3, the discharge valve 14, the water vapor outlet 11 and the heating source 5 are controlled by a processor 20, which co-operates with said sensors 2, 6, 8, 9, 10, 19 and 21, and the timer 7. The electrical connections necessary for this purpose are only diagrammatically shown in Fig. 1.

The intake valve 3 is controlled by the processor 20 to regulate the flow of water from the storage tank 1 to the heating chamber 4. During a start-up phase of the water treatment apparatus, the discharge valve 14 is closed and the water vapor outlet 11 is open. The intake valve 3 is opened by the processor 20. Since the storage tank 1 is situated in a higher position than the heating chamber 4, the force of gravity is used to transport unpurified water from the inlet via the intake valve 3 to the heating chamber 4. The water vapor outlet 11 is open, so that the air present in the heating chamber 4 can escape from the heating chamber 4 during the filling process. By making use of the force of gravity, the water treatment apparatus does not require special means for filling the heating chamber 4 during the start-up phase. When the second level sensor 8 detects a predetermined maximum level of water in the heating chamber 4, the intake valve 3 and the water vapor outlet 11 are closed by the processor 20 and the start-up phase ends.

After closing the intake valve 3 and the water vapor outlet 11, a first phase of a heat-exchange process in the heating chamber 4 starts in said heating chamber 4. In this phase, the unpurified water present in the heating chamber 4 is heated to a predetermined temperature at which it is maintained for a predetermined period of time. During the first phase, the discharge valve 14, the intake valve 3 and the water vapor outlet 11 are closed. The heating source 5 is activated by the processor 20. The heating source 5 is formed, in this embodiment, by a helical electrical heating element, but it may alternatively be formed by a different type of heating source. The heating source 5 heats the unpurified water in the heating chamber 4 to a predetermined temperature, in this embodiment 121°C. The temperature of the water in the heating chamber 4 is measured by the temperature sensor 6. The timer 7 sends a signal to the processor 20 to maintain said temperature for a predetermined period of time, in this embodiment 7 minutes, in order to kill the bacteria in the water and remove other impurities, such as chlorine and volatile organic compounds, such as trihalomethanes, in the form of

vapor from the water. In the first phase of the heat-exchange process, the heating of the water and the formation of vapor causes an overpressure in the heating chamber 4, in this embodiment approximately 2 bar at a temperature of 121°C. This ends the first phase of the heat-exchange process in the heating chamber 4.

The intake valve 3, the discharge valve 14 and the water vapor outlet 11 are closed during the first phase, so that the build-up of said overpressure during the first phase is not disturbed by open communications with, respectively, the storage tank 1, the further storage tank 17 and the drip can 13. By using said second level sensor 8, the water level in the heating chamber 4 does not rise above a predetermined maximum level during the filling process, so that a free space remains above the water in the heating chamber 4. In this manner, expansion of water in the heating chamber 4 during the first phase of the heat-exchange process is made possible, and too high a pressure in the heating chamber 4 is precluded.

After said first phase of the heat-exchange process, a transport phase takes place in the water treatment apparatus, in which phase, purified water is transported from the heating chamber 4 to the outlet, under the influence of the overpressure generated in the heating chamber 4 during the first phase of the heat-exchange process. The first phase of the heat-exchange process is efficiently used since, as mentioned hereinabove, during this phase, firstly, the water present in the heating chamber 4 is purified and, secondly, the overpressure causing the transport phase is generated. At the beginning of the transport phase, the discharge valve 14 is opened by the processor 20, while the intake valve 3 and the water vapor outlet 11 remain closed. In this manner, it is precluded that, during the transport phase, purified water flows from the heating chamber 4 via the intake valve 3 to the storage tank 1 for unpurified water and via the water vapor outlet 11 to the drip can 13. During the transport phase, purified water is transported from the heating chamber 4, via the discharge valve 14, the filter 15 and the heat exchanger 16, to the further storage tank 17 for purified water. The filter 15 collects hydroxides and lime granules from the water. In this embodiment, a sand filter is employed, but a different type of filter may alternatively be used. The heat exchanger 16 cools the purified water, in this embodiment, to approximately 60°C. The cooling element 18 cools the purified water in the further storage tank 17 to a lower temperature, in this embodiment approximately 8°C, whereafter the water can be used as drinking water or for other applications requiring cool, clean water. It is noted that after the filter 15 a draw-off point can be placed where hot, purified water can be drawn off. When, during the transport phase wherein purified water is transported from the heating chamber 4 to the outlet, the third level sensor 9 detects a predetermined minimum level of water in the heating chamber 4, the

discharge valve 14 is closed by the processor 20. In this manner, sufficient water remains in the heating chamber 4 to serve as a boiling-dry protection. Closing the discharge valve 14 also precludes that purified water flows back into the heating chamber 4 after the transport phase. This ends the transport phase.

After the transport phase has ended, the heating chamber 4 contains water vapor comprising a concentration of impurities such as chlorine and volatile organic compounds, such as trihalomethanes. This water vapor has formed during the first phase of the heat-exchange process in the heating chamber 4. The water vapor outlet 11 is subsequently opened by the processor 20 to allow said water vapor containing impurities to leave the heating chamber 4. The intake valve 3 and the discharge valve 14 remain closed in this process. In this manner, the impurities are rapidly removed from the heating chamber 4. This water vapor containing impurities condenses in the condenser 12, and the condensed water is collected in the drip can 13. In this manner, it is precluded that, as a result of dissemination of the released water vapor, impurities land at undesirable locations in the water treatment apparatus or arrive in the air in the surroundings of the water treatment apparatus. Subsequently, the heating source 5 is switched off by the processor 20. The temperature of the water vapor in the heating chamber 4 is measured by the temperature sensor 6. After cooling of the water vapor to a predetermined intermediate temperature in the heating chamber 4, in this embodiment approximately 103°C, the water vapor outlet 11 is closed by the processor 20. The discharge valve 14 and the intake valve 3 also remain closed. At this moment, the heating chamber 4 is still saturated with water vapor.

Subsequently, a second phase of the heat-exchange process starts in the heating chamber 4. In this phase, condensation takes place as a result of cooling the water vapor present in the heating chamber 4 to a predetermined temperature, which water vapor has been formed by heating water during the first phase of the heat-exchange process. When the temperature in the heating chamber 4 has decreased to ± 100°C, the water vapor present condenses, resulting in a relatively large underpressure in the heating chamber 4. This ends the second phase of the heat-exchange process in the heating chamber 4. During this second phase, the intake valve 3, the discharge valve 14 and the water vapor outlet 11 are closed. In this manner, the build-up of said underpressure during the second phase is not disturbed by open communications with, respectively, the storage tank 1, the further storage tank 17 and the drip can 13.

After said second phase of the heat-exchange process, a further transport phase takes place in the apparatus, wherein unpurified water is transported from the inlet to the

heating chamber 4 under the influence of the underpressure generated during the second phase of the heat-exchange process in the heating chamber 4. At the beginning of said further transport phase, the intake valve 3 is opened by the processor 20, while the discharge valve 14 and the water vapor outlet 11 remain closed. In this manner, it is precluded that during the further transport phase, purified water flows from the further storage tank 17 for purified water via the discharge valve 14 to the heating chamber 4, and that air is drawn in via the water vapor outlet 11. During the further transport phase, unpurified water is transported from the storage tank 1 for unpurified water, via the intake valve 3, to the heating chamber 4. As there is a relatively substantial underpressure, the unpurified water flows relatively rapidly from the inlet into the heating chamber 4. When the second level sensor 8 detects the predetermined maximum level of water in the heating chamber 4, the intake valve 3 is closed by the processor 20.

The heat-exchange process in the apparatus is a cyclic process, and after the above-mentioned further transport phase, the above-mentioned first phase of the heat-exchange process starts again in the heating chamber 4. The cyclic process causes a quantity of purified cool water to be repetitively generated at the outlet, here the further storage tank 17. In this manner, a continuous production of purified water can be achieved, while the dimensions of the heating chamber 4 can be limited.

As the transport of water through the water treatment apparatus in accordance with the invention takes place by means of the overpressure and the underpressure in the heating chamber 4, which are generated during, respectively, the first phase and the second phase of the heat-exchange process in the heating chamber 4, a pump or continuous connection to the water main is not necessary. The overpressure in the heating chamber 4 causes the water present there to flow from the heating chamber to the outlet, while the underpressure in the heating chamber 4 causes unpurified water to flow from the inlet into the heating chamber 4.

In the first embodiment, the processor 20 regulates the intake valve 3, the discharge valve 14, the water vapor outlet 11 and the heating source 5 so as to control the transport of water in the apparatus in a practical manner in co-operation with said sensors 2, 6, 8, 9, 10, 19 and 21, and the timer 7. The sensors control and protect the operation of the apparatus. By signals from the processor 20, the user of the water treatment apparatus is also made aware of any actions necessary to ensure a proper operation of the water treatment apparatus. For example, when the first level sensor 2 detects a predetermined minimum level of unpurified water in the storage tank 1, the processor 20 signals that the storage tank 1

should be filled up. When the pressure sensor 10 detects a predetermined maximum overpressure in the heating chamber 4, which exceeds the overpressure occurring under normal conditions during the water treatment process, the water treatment apparatus is deactivated by the processor 20 and said processor 20 produces an alarm signal. In this manner, apart from the second level sensor 8, an additional protection is built in to preclude too high a pressure in the heating chamber 4.

When the fourth level sensor 19 detects a predetermined maximum level of water in the further storage tank 17 for purified water, the processor 20 signals that water should be drawn off from the further storage tank 17. The processor 20 sets the water treatment apparatus in a pause until the level in the further storage tank 17 has gone down to a predetermined minimum level. When the fifth level sensor 21 detects this predetermined minimum level, the water treatment apparatus is put into operation again by the processor 20. In an alternative embodiment, a fifth level sensor 21 is dispensed with, and, when water is drawn off, the fourth level sensor 19 detects a level below the predetermined maximum level and the water treatment apparatus is put into operation again by the processor 20.

The Figs. 2a, 2b and 2c show a heating chamber 4" of a second embodiment of the water treatment apparatus in accordance with the invention during a number of successive phases in a heat-exchange process. The heating chamber 4" differs from the heating chamber 4 of the first embodiment in the manner described hereinbelow. The second embodiment of the water treatment apparatus in accordance with the invention further predominantly comprises the same components as the first embodiment shown in Fig. 1. These corresponding components are not shown in the Figs. 2a, 2b and 2c. Corresponding parts of the heating chambers 4 and 4" bear the same reference numerals in the Figs. 2a, 2b and 2c.

The heating chamber 4" of the second embodiment of the water treatment apparatus in accordance with the invention, as shown in Figs. 2a, 2b and 2c, comprises, in stead of the second level sensor 8 employed in the heating chamber 4 of the first embodiment, an elastic membrane 22 which is secured at some distance from a top wall of the heating chamber 4" and approximately parallel thereto. The membrane 22 is connected to a pipe 24, the space underneath the membrane 22 being in communication with the water vapor outlet 11 via a central opening 26 formed in the membrane 22. The pipe 24 is guided so as to be displaceable in a vertical direction in the top wall of the heating chamber 4". In addition, a partition 23 having openings 25 is arranged in the upper part of the heating chamber 4", underneath the membrane 22 and approximately parallel thereto. Fig. 2a shows the membrane 22 in the heating chamber 4" in an untensioned horizontal position when there is no

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overpressure or underpressure in the heating chamber 4". The pipe 24 connected to the membrane 22 is in a neutral position. In Fig. 2b, the membrane 22 in the heating chamber 4" is bent downward, i.e. an underpressure prevails in the heating chamber 4". As a result, the pipe 24 connected to the membrane 22 is displaced vertically downward with respect to the neutral position, and the membrane 22 is supported by the partition 23 in the heating chamber 4". In Fig. 2c, the membrane 22 in the heating chamber 4" is bent upward, i.e. an overpressure exists in the heating chamber 4". As a result, the pipe 24 connected to the membrane 22 is displaced vertically upward with respect to the neutral position, and the membrane 22 is supported by the top wall of the heating chamber 4.

In the second embodiment, water is transported through the apparatus in a manner corresponding to the first embodiment, and also the flow of the water through the apparatus is controlled in a corresponding manner. In the water treatment apparatus, a comparable start-up phase takes place. By using the elastic membrane 22 and the openings 25 in the partition 23, the heating chamber 4" allows of being entirely, i.e. up to the membrane 22, filled with water during the start-up phase. Subsequently, a comparable first phase of a heat-exchange process takes place. As a result of the overpressure which develops during the first phase of the heat-exchange process, the membrane 22 in the heating chamber 4" bends upward and causes the pipe 24 connected to the membrane 22 to move in the same direction, as shown in Fig. 2c. In this manner, the membrane 22 deals with the increase in volume caused by the expansion of the water and the formation of water vapor, so that too high a pressure on the heating chamber 4" is precluded. Next, a comparable transport phase takes place, which is followed by a comparable release of water vapor from the heating chamber 4" and a comparable second phase of the heat exchange process. As a result of the underpressure which develops during the second phase of the heat-exchange process, the membrane 22 in the heating chamber 4" bends downward, causing the pipe 24 connected to the membrane 22 in the heating chamber 4" to move downward too, as shown in Fig. 2b. The partition 23 supports the membrane 22 in the heating chamber 4", so that excessive bending of the membrane 22 under the influence of the underpressure is precluded. After this second phase, a comparable further transport phase takes place. By using the elastic membrane 22 and the openings 25 in the partition 23, the heating chamber 4" allows of being entirely, i.e. up to the membrane 22, filled with water during the further transport phase, as is shown in Fig. 2b. The heat-exchange process in the apparatus also is a cyclic process, and after said comparable further transport phase, the above-mentioned comparable first phase of the heat-exchange process starts again in the water treatment apparatus.

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The third embodiment of the water treatment apparatus in accordance with the invention, as shown in Fig. 3, substantially comprises the same parts as the first embodiment shown in Fig. 1. The parts in Fig. 3 corresponding to parts in Fig. 1 bear the same reference numerals. Hereinbelow, only the most important differences between the first and the third embodiment are discussed.

The third embodiment of the water treatment apparatus in accordance with the invention comprises, between the inlet and the outlet, a first heating chamber 4 and, arranged parallel thereto, an identical second heating chamber 4' wherein, in operation, the two phases of the heat-exchange process occur in phase opposition. The parts in the second heating chamber 4' which correspond to parts in the first heating chamber 4 are indicated by means of the same reference numerals in Fig. 3, yet with an accent ('). The third embodiment further comprises, after the filter 15, a combined condenser/cooler 31 and a heat exchanger 30. The combined condenser/cooler 31 is arranged between the water vapor outlets 11, 11' and the drip can 13, and between the discharge valves 14, 14' and the heat exchanger 30. The heat exchanger 30 is arranged between the storage tank 1 for unpurified water and the intake valves 3, 3', and between the combined condenser/cooler 31 and the further storage tank 17 for purified water.

In the third embodiment water is transported through the apparatus in a manner which is comparable to that in the first embodiment, and the flow of the water through the apparatus is controlled in a comparable manner. During a comparable start-up phase, the heating chambers 4 and 4' are both filled with unpurified water. In this embodiment, the processor 20 regulates, after the start-up phase, the intake valve 3, the discharge valve 14, the water vapor outlet 11 and the heating source 5 so as to be in phase opposition to the intake valve 3', the discharge valve 14', the water vapor outlet 11' and the heating source 5'. After the start-up phase, a comparable first phase of a heat-exchange process takes place in the first heating chamber 4, which first phase is followed by a comparable transport phase. During these phases, the filled second heating chamber 4' remains at rest. During the transport phase, purified water is transported from the first heating chamber 4, via the discharge valve 14, the filter 15, the combined condenser/cooler 31 and the heat exchanger 30, to the further storage tank 17. The combined condenser/cooler 31 cools the water, in this embodiment to 60°C, and the heat exchanger 30 cools the water to a lower temperature, in this embodiment 20°C. Subsequently, water vapor with impurities is released, in a comparable manner, from the first heating chamber 4 via the water vapor outlet 11, said water vapor condensing in the combined condenser/cooler 31.

Subsequently, on the one hand, said first phase of the heat-exchange process starts in the second heating chamber 4' and, on the other hand, a comparable second phase of a heat-exchange process starts in the first heating chamber 4.

Subsequently, on the one hand, said transport phase wherein purified water is transported from the second heating chamber 4' to the further storage tank 17 takes place in the water treatment apparatus. On the other hand, a comparable further transport phase wherein unpurified water is transported from the inlet to the first heating chamber 4 takes place in the water treatment apparatus. During this further transport phase, the unpurified water traveling to the first heating chamber 4 is heated in the heat exchanger 30 by the purified water which travels from the second heating chamber 4', via the heat exchanger 30, to the further storage tank 17. In this manner, effective heat generation and effective cooling by means of the heat exchanger 30 is achieved. After the transport phase from the second heating chamber 4', water vapor containing impurities is released from the second heating chamber 4'. The heat-exchange process in the apparatus is also a cyclic process. After the transport phase and the release of water vapor, the second phase in the heat-exchange process starts in the second heating chamber 4', and, after the further transport phase, the first phase in the heat-exchange process starts again in the first heating chamber 4. Both phases of the heat-exchange process are also repeated in the apparatus as long as unpurified water is available at the inlet. By using said two parallel-arranged heating chambers 4 and 4', a large quantity of purified water is efficiently generated and a uniform transport of water, and hence a more uniform production of purified water, is achieved.

It is noted that more than two heating chambers may be used in the water treatment apparatus, wherein the two phases are in phase opposition in a uniform manner.

In the water treatment apparatus in accordance with the invention, a sand filter may be used but, alternatively, other types of filters may be used. It is advantageous to apply a removable, disposable filter, so that the user can replace the filter, when it is full, with a new, clean filter. The water treatment apparatus in accordance with the invention can be used as an independent apparatus for generating cool, purified water. It may alternatively be used as a part of other apparatus which make use of purified water, such as a beverage dispenser or a coffee vending machine.

CLAIMS:

A water treatment apparatus comprising:

- an inlet for unpurified water;
- a heating chamber for purifying water by heating;
- a heating source for heating water in the heating chamber;
- an outlet for purified water,

characterized in that, in operation, transport of purified water from the heating chamber to the outlet, and transport of unpurified water from the inlet to the heating chamber, take place in the apparatus by means of, respectively, an overpressure and an underpressure, which develop in the heating chamber during, respectively, a first phase and a second phase of a heat-exchange process in the heating chamber.

2. A water treatment apparatus as claimed in claim 1, characterized in that the first phase of the heat-exchange process includes heating of the unpurified water present in the heating chamber to a predetermined temperature, and maintaining said temperature during a predetermined period of time.

3. A water treatment apparatus as claimed in claim 1, characterized in that the apparatus comprises a discharge valve between the heating chamber and the outlet, which discharge valve is closed during the first and the second phase of the heat-exchange process and open during a transport phase between the first and the second phase of the heat-exchange process.

4. A water treatment apparatus as claimed in claim 2, characterized in that the second phase of the heat-exchange process includes condensation as a result of cooling water vapor present in the heating chamber to a predetermined temperature, which water vapor is formed by heating water during the first phase of the heat-exchange process.

5. A water treatment apparatus as claimed in claim 1, characterized in that the apparatus comprises an intake valve between the inlet and the heating chamber, which intake

valve is closed during the first and the second phase of the heat-exchange process and open during a further transport phase after the second phase.

6. A water treatment apparatus as claimed in claim 1, characterized in that the heat-exchange process in the apparatus is a cyclic process.

7. A water treatment apparatus as claimed in claim 1, characterized in that the apparatus comprises a storage tank for unpurified water which is situated in a higher position than the heating chamber.

8. A water treatment apparatus as claimed in claim 2, characterized in that the apparatus comprises a closable water vapor outlet allowing water vapor with impurities, which is formed during the first phase of the heat-exchange process, to be released from the heating chamber.

9. A water treatment apparatus as claimed in claim 8, characterized in that the apparatus is provided with a condenser for the condensation of the water vapor, and with a drip can for receiving the condensed water vapor with impurities.

10. A water treatment apparatus as claimed in claim 1, characterized in that the apparatus comprises an elastic membrane in the heating chamber.

11. A water treatment apparatus as claimed in claim 10, characterized in that the apparatus comprises, in the heating chamber near the membrane, a partition with apertures.

12. A water treatment apparatus as claimed in claim 1, characterized in that between the inlet and the outlet the apparatus comprises at least two parallel-arranged heating chambers wherein, in operation, the two phases of the heat-exchange process take place in phase opposition.

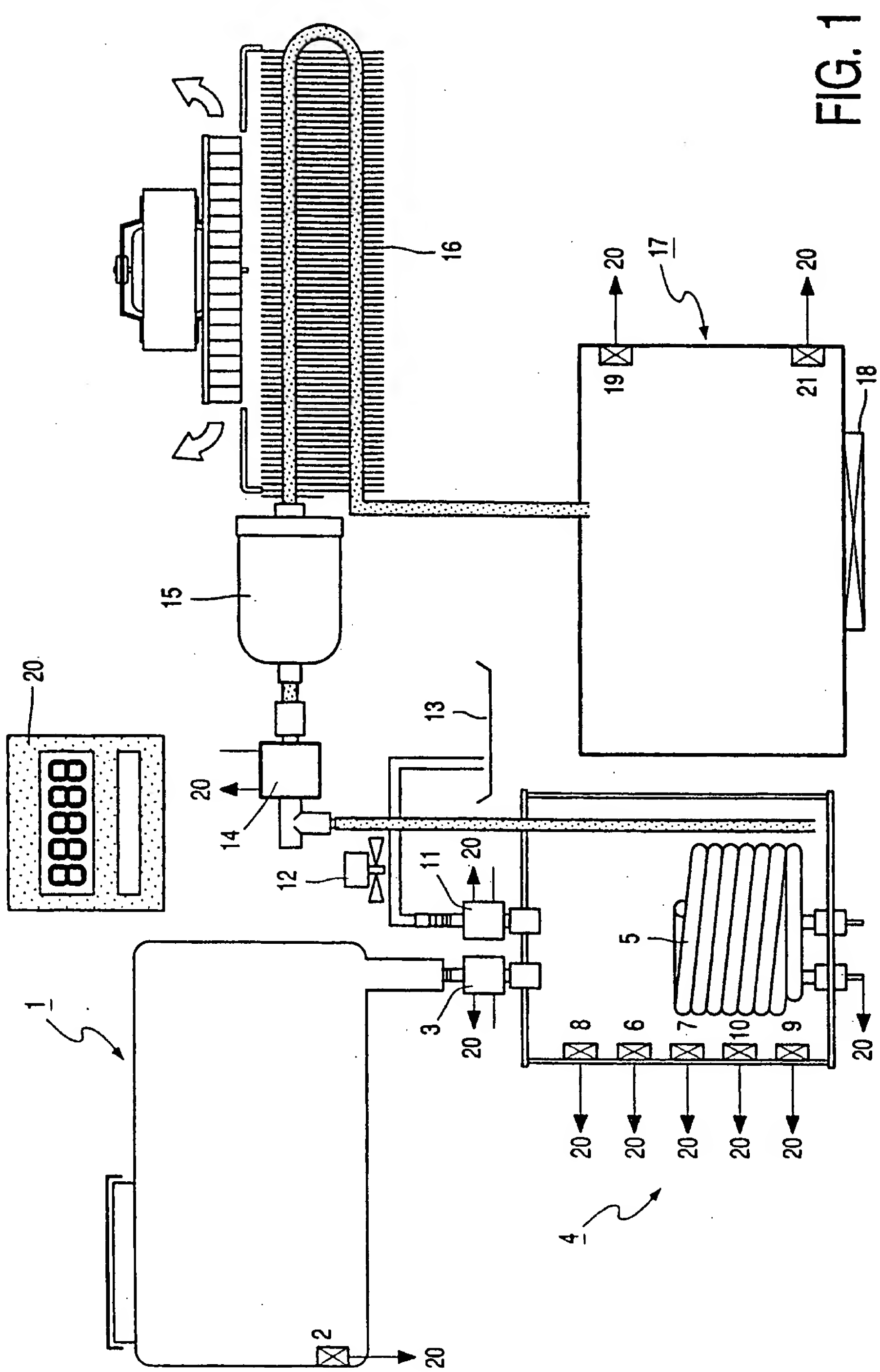

FIG. 1

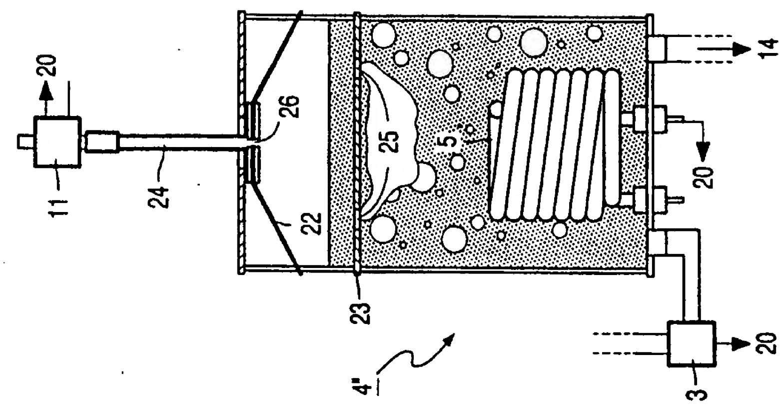

FIG. 2C

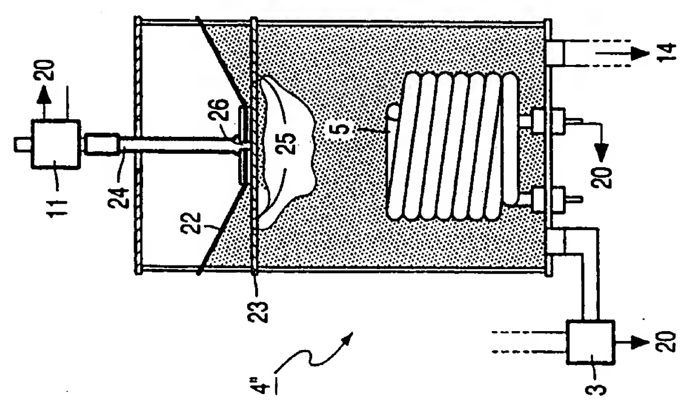

FIG. 2B

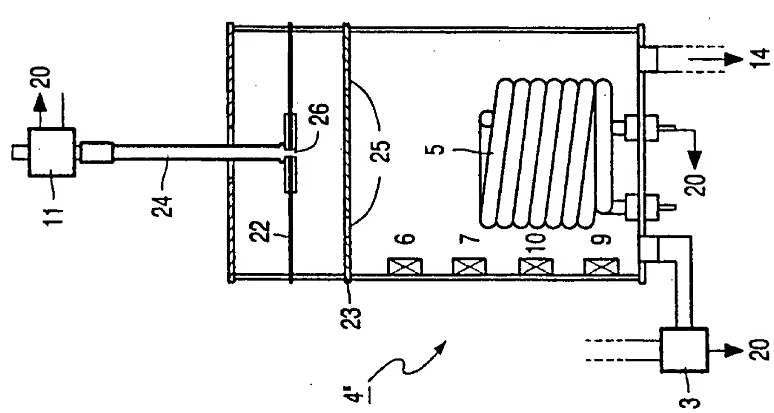

FIG. 2A

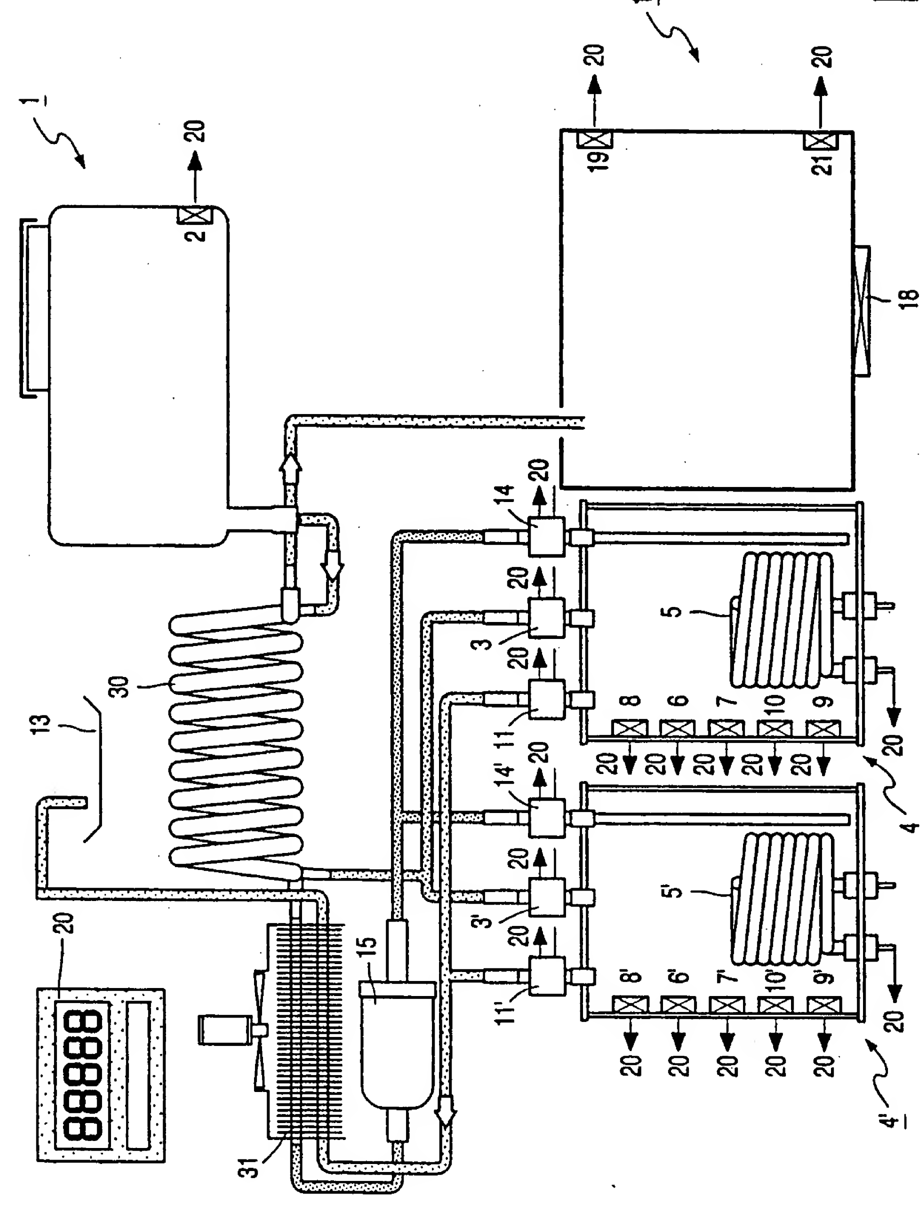

FIG. 3

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/EP 00/01904

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C02F1/02 A47J31/54

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C02F A61L A47J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 253 029 A (WANG KENG BEN) 20 January 1988 (1988-01-20) column 3, line 11-21 column 4, line 9-26; figure 7	1-7
A	US 5 858 248 A (PLESTER GEORGE ET AL) 12 January 1999 (1999-01-12) column 8, line 11 -column 9, line 4; figures 1,2	1-3,5,6, 8,9
A	FR 2 562 060 A (INTERCONTINENTAL WATER CORP) 4 October 1985 (1985-10-04) page 10, line 8-18; figures 1,2	1,2,5,6
A	DE 14 29 991 A (KAPHENGST J) 27 March 1969 (1969-03-27) page 4, paragraph 2 -page 6, paragraph 3; figure 1	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2000	21/08/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Gruber, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 00/01904

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US 5858248 A	12-01-1999	AU 5662696 A	16-10-1996
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